PATENT COOPERATION TREATY

From the
INTERNATIONAL PRELIMINARY EXAMINING AUTHORITY

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PCT

NOTIFICATION OF TRANSMITTAL OF INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Rule 71.1)

Date of Mailing *(day/month/year)* 09 OCT 2003	
Applicant's or agent's file reference 30750-PCT	**IMPORTANT NOTIFICATION**

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US02/22618	16 July 2002 (16.07.2002)	16 July 2001 (16.07.2001)

Applicant

MIOX CORPORATION

1. The applicant is hereby notified that this International Preliminary Examining Authority transmits herewith the international preliminary examination report and its annexes, if any, established on the international application.

2. A copy of the report and its annexes, if any, is being transmitted to the International Bureau for communication to all the elected Offices.

3. Where required by any of the elected Offices, the International Bureau will prepare an English translation of the report (but not of any annexes) and will transmit such translation to those Offices.

4. **REMINDER**

The applicant must enter the national phase before each elected Office by performing certain acts (filing translations and paying national fees) within 30 months from the priority date (or later in some Offices)(Article 39(1))(see also the reminder sent by the International Bureau with Form PCT/IB/301).

Where a translation of the international application must be furnished to an elected Office, that translation must contain a translation of any annexes to the international preliminary examination report. It is the applicant's responsibility to prepare and furnish such translation directly to each elected Office concerned.

For further details on the applicable time limits and requirements of the elected Offices, see Volume II of the PCT Applicant's Guide.

Name and mailing address of the IPEA/US	Authorized officer
Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450	Krishnan S Menon Telephone No. 703-308-0661
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Form PCT/IPEA/416 (July 1992)

PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference 30750-PCT	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/US02/22618	International filing date *(day/month/year)* 16 July 2002 (16.07.2002)	Priority date *(day/month/year)* 16 July 2001 (16.07.2001)
International Patent Classification (IPC) or national classification and IPC IPC(7): B01D 63/00, 61/00, 61/02; C02F 9/00, 1/44; F04B 49/00, 25/00,3/00,5/00, 17/00, 35/00 and US Cl.: 210/650-653, 258-260, 321.76, 321.85, 91, 416.1, 416.3; 417/63, 262.403		
Applicant MIOX CORPORATION		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 6 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e., sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 10 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the report
   - II ☐ Priority
   - III ☐ Non-establishment of report with regard to novelty, inventive step and industrial applicability
   - IV ☒ Lack of unity of invention
   - V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
13 February 2003 (13.02.2003)	04 September 2003 (04.09.2003)
Name and mailing address of the IPEA/US Mail Stop PCT, Attn: IPEA/US Commissioner for Patents P.O. Box 1450 Alexandria, Virginia 22313-1450 Facsimile No. (703)305-3230	Authorized officer Krishnan S Menon Telephone No. 703-308-0661

Form PCT/IPEA/409 (cover sheet)(July 1998)

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US02/22618

I. Basis of the report

1. With regard to the **elements** of the international application:*

☐ the international application as originally filed.

☒ the description:
pages 1, 3-6, 8-12 as originally filed
pages _____, filed with the demand
pages 2,7, filed with the letter of 07 July 2003 (07.07.2003).

☒ the claims:
pages NONE, as originally filed
pages NONE, as amended (together with any statement) under Article 19
pages NONE, filed with the demand
pages 13-19, filed with the letter of 07 July 2003 (07.07.2003).

☒ the drawings:
pages NONE, as originally filed
pages NONE, filed with the demand
pages 1, filed with the letter of 07 July 2003 (07.07.2003).

☐ the sequence listing part of the description:
pages NONE, as originally filed
pages NONE, filed with the demand
pages NONE, filed with the letter of _____.

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.
These elements were available or furnished to this Authority in the following language _____ which is:

☐ the language of a translation furnished for the purposes of international search (under Rule23.1(b)).

☐ the language of publication of the international application (under Rule 48.3(b)).

☐ the language of the translation furnished for the purposes of international preliminary examination(under Rules 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

☐ contained in the international application in printed form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. ☐ The amendments have resulted in the cancellation of:

☐ the description, pages NONE

☐ the claims, Nos. NONE

☐ the drawings, sheets/fig NONE

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).**

** Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17).*
*** Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.*

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US02/22618

IV. Lack of unity of invention

1. In response to the invitation to restrict or pay additional fees the applicant has:

- ☐ restricted the claims.
- ☒ paid additional fees.
- ☐ paid additional fees under protest.
- ☐ neither restricted nor paid additional fees.

2. ☐ This Authority found that the requirement of unity of invention is not complied with and chose, according to Rule 68.1, not to invite the applicant to restrict or pay additional fees.

3. This Authority considers that the requirement of unity of invention is accordance with Rules 13.1, 13.2 and 13.3 is

- ☐ complied with.
- ☒ not complied with for the following reasons:

This application contains the following inventions or groups of inventions which are not so linked as to form a single general inventive concept under PCT Rule 13.1. In order for all inventions to be examined, the appropriate additional examination fees must be paid.

I. Claims 1-36 and 56-64, drawn to a filtration system
II. Claims 37-55, drawn to a method for filtering

The inventions listed as Groups I and II do not relate to a single general inventive concept under PCT Rule 13.1 because, under PCT Rule 13.2, they lack the same or corresponding special technical features for the following reasons: The special technical feature of claim 1 is a pump producing an optimized pulsed fluid flow, which is shown by the prior art US 6,017,200 A (CHILDS), and X reference, to lack novelty or inventive step and does not make a contribution over the prior art.

4. Consequently, the following parts of the international application were the subject of international preliminary examination in establishing this report:

- ☒ all parts.
- ☐ the parts relating to claims Nos. ____

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US02/22618

V. Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. STATEMENT

Novelty (N)	Claims	19-36, 46-48, 50-55	YES
	Claims	1-18, 37-45, 49, 56-64	NO
Inventive Step (IS)	Claims	NONE	YES
	Claims	1-64	NO
Industrial Applicability (IA)	Claims	1-64	YES
	Claims	NONE	NO

2. CITATIONS AND EXPLANATIONS

Please See Continuation Sheet

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No.
PCT/US02/22618

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

V. 2. Citations and Explanations:

1. Claims 1,3-5,7-18, 37, 39-45,49,56, and 58-64 lack novelty under PCT Article 33(2) as being anticipated by US 6,017,200 A(CHILDS).

Childs teaches a filtration system comprising a filtration element and a pump as in claim 1, dual head pump as in claim 3, having primary and secondary heads of different swept volumes as in claim 4, fixed recovery as in claim 5, retentate head smaller than feed head as in claim 7, shaft or hydraulic connections between the heads as in claims 8-10, retentate head offsets the force on the feed head as in claim 12, hydraulically operated valves as in claims 13-16 to provide pressure recovery, which reduces energy required as in claim 17, system has a reverse osmosis element as in claim 18, dual head pump, with connection between the two heads, filtration element and hydraulically actuated valve as in claim 56, valve connection mechanical shaft or hydraulic as in claims 58-60, valve actuation as in claims 61-64.

Childs teaches a method of filtration by providing a filtration element, a pulsed flow pump, with varying a parameter of the pulsed flow to optimize a desired characteristic of the permeate filtered by the element and the pump as in claim 37, dual head pump as in claim 39, pump heads connected together as in claim 40, operation of the pump as in claims 41-43, with pressure recovery, which reduces energy required as in claim 44, and the filter element comprises a reverse osmosis element as in claim 45. Varying a parameter comprises varying pulse frequency or amplitude as in claim 49.

2. Claim 1-6,37,38,56 and 57 lack novelty under PCT Article 33(2) as being anticipated by US Re 32,144 A (KEEFER).

Keefer teaches a filtration system and method of filtering with filtration element and double head pump as in the instant claims with diaphragm pumps as in claims 2, 6, 38, and 57.

3. Claims 19-36, 46-48 and 50-55 lack an inventive step under PCT Article 33(3) as being obvious over US 6,017,200 A (CHILDS) in view of US 4,861,487 A (FULK Jr.).

Childs teaches all the elements of claims 19 and 45. The instant claims add details of a spiral wound element, which Childs does not teach. Fulk teaches such details. It would be obvious to one of ordinary skill in the art at the time of invention to use the teaching of Fulk in the teaching of Childs because Childs does not teach any specific reverse osmosis membrane element.

Claims 30-33 and 50-52 recite permeate quality monitoring devices - flow and conductivity meters, which Childs in view of Fulk does not specifically teach. However, Childs teaches electronic control units, variable frequency drives, variable flow capabilities, etc, which cannot be performed without proper metering and monitoring devices. Also, flow meters and conductivity meters are also commonly used in the water purification industry, and therefore, does not constitute an inventive step.

Supplemental Box
(To be used when the space in any of the preceding boxes is not sufficient)

Claims 34-36 and 53-56 recite feedback loop with electrical measurement device measuring amperage load on the system, and minimizing the load. Childs teaches feedback control loops, and minimizing the Load energy required for the process by energy recovery, but Childs in view of Fulk does not specifically state amperage load measurements. However, measuring the amperage on electrical systems is commonly practiced to monitor the energy load on the system, and therefore, does not constitute an inventive step.

4. Claims 1-64 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in desalination or dialysis industry.

---------- NEW CITATIONS ----------

F { US 4,178,240 A (PINKERTON) 11 December 1979, figures, especially fig 2; col 1 line 60 col 2 line 16; col 3 line 3 - col 4 line 10
US 3,825,122 (TAYLOR) 23 July 1974; figures; col 4 lines 15-60.

U.S. Patent No. 5,496,466, to Gray, discloses a portable water purification system with a double piston pump comprising a feed water piston in a feed water cylinder, a concentrate pumping section for removing concentrate from concentrate output, and a concentrate pumping section including a concentrate cylinder and piston wherein the pistons move in opposite axially directions. Gray does not teach differential pressure control or use of a spring or other mechanism for storing energy to average out the forces of the respective strokes. Further, Gray teaches use of a two-piston system only.

U.S. Patent No. 5,503,736, to Schoenmeyr, discloses a booster pump for a reverse osmosis water purification system wherein the pump has a spring return piston stroked by the pressure of feedwater and a pair of solenoid control valves (controlled by a piston position detector switch) that control the flow of feedwater into and out of the pump to move the piston between stroke and return positions. The Schoenmeyr patent, while disclosing a single piston, employs a two-headed piston with solenoid control valves and a control circuit system, unlike the differential pressure activated valve of the present invention.

Additional tangentially related prior art includes: U.S. Patent No. 5,589,066, to Gray; U.S. Patent No. 5,865,980 to Patapoff et al.; U.S. Patent No. 3,966,364, to Bachle et al.; U.S. Patent No. 5,531,887, to Miers; U.S. Patent No. 4,740,301, to Lopez; and U.S. Patent No. 3,830,372, to Manjikian.

SUMMARY OF THE INVENTION (DISCLOSURE OF THE INVENTION)

The present invention is of a pumping apparatus and method comprising: providing a dual head pump comprising a primary feed head comprising a feed diaphragm and a secondary retentate head comprising a retentate diaphragm; pumping fluid to at least one membrane surface; transferring force from the retentate diaphragm to the feed diaphragm to recover energy; providing a fixed recovery via the two heads; and imparting a pulsing pressure wave on the membrane surface. In the preferred embodiment, pumping fluid comprises providing feed

downstream of feed head **28** from returning to feed head **28** during the suction stroke of pump **20**. Fluid discharged from feed head **28** discharge port **36** is transferred to feed inlet port **60** on RO element **22**.

Benefits of thin feed spacer designs in RO elements are discussed below. These benefits include more membrane surface per RO element volume, concentration polarization reduction via TDS diffusion effects, and increased surface velocity and shear, all of which contribute to increased RO element throughput and product water quality. Although thin feed spacers are preferable in the system of the present invention, conventional feed spacer elements may also be used. Thin feed spacer elements improve the overall efficiency and throughput of the system because there is more membrane area in the same element size housing.

Permeate, or product water, from RO element **22** is discharged through permeate water port **64**. High TDS retentate water is discharged from RO element **22** via retentate discharge port **62**. Assuming no expansion of RO element **22** and hydraulic lock of the system (no air), the law of conservation of mass dictates that the volume of water entering RO element **22** inlet port **60** equals the sum of the volume of water discharged at permeate discharge port **64** and retentate discharge port **62**. Recovery in an RO element is defined as the volume of permeate (or product water) discharged from an RO element versus the feed water entering the element. Therefore, the recovery of an RO element is explicitly defined by the ratio of the swept volume of pump **20** feed head **28** versus the volume of retentate head **30**. The difference in volume between the RO element feed volume and the retentate volume is the permeate, or product water, volume.

In order for energy recovery as well as fixed recovery (ratio of permeate to feed) to work, the discharge port retentate head **30** is closed in order for pressure to build up in the system. The ultimate pressure obtained is a function of the osmotic pressure of the feed water in RO element **22**. Closure of the discharge port of retentate pump head **30** is achieved with differential pressure activated (DPA) valve **24**. DPA valve **24** is activated by equal pressures applied across

CLAIMS

What is claimed is:

1. A filtration system comprising:
a pump producing an optimized pulsed fluid flow; and
a filtration element.

2. The filtration system of claim 1 wherein said pump is a diaphragm pump.

3. The filtration system of claim 1 wherein said pump is a dual head pump.

4. The filtration system of claim 3 wherein said pump comprises:
a primary feed head; and
a secondary retentate head;
wherein said two heads comprise different swept volumes.

5. The filtration system of claim 4 wherein said two heads provide a fixed recovery.

6. The filtration system of claim 5 wherein said two heads comprise diaphragms of differing radii.

7. The filtration system of claim 4 wherein said secondary retentate head is smaller than said primary feed head.

8. The filtration system of claim 4 further comprising a connection between said two heads.

9. The filtration system of claim 8 wherein said connection is mechanical.

10. The filtration system of claim 9 wherein said connection is a shaft.

11. The filtration system of claim 8 wherein said connection is hydraulic.

12. The filtration system of claim 8 wherein a force on said secondary retentate head offsets a force on said primary feed head.

13. The filtration system of claim 12 further comprising a differential pressure activated valve.

14. The filtration system of claim 13 wherein said valve seals a discharge port of said retentate head when a feed pressure exceeds a retentate pressure.

15. The filtration system of claim 14 wherein said valve is hydraulically activated.

16. The filtration system of claim 14 wherein said connection and said valve provide a pressure recovery to said filtration system.

17. The filtration system of claim 16 wherein said pressure recovery reduces energy required to operate said filtration system.

18. The filtration system of claim 1 wherein said filtration element comprises a reverse osmosis element.

19. The filtration system of claim 18 wherein said reverse osmosis element comprises a spiral wrapped element.

20. The filtration system of claim 19 wherein said spiral wrapped element comprises:

at least one membrane; and

at least one thin feed spacer.

21. The filtration element of claim 20 wherein said at least one thin feed spacer comprises a plastic web mesh.

22. The filtration system of claim 20 wherein said at least one thin feed spacer is less than approximately .025 inches thick.

23. The filtration system of claim 20 wherein said at least one thin feed spacer is less than approximately .011 inches thick.

24. The filtration system of claim 20 wherein said at least one thin feed spacer provides for a reduction in an amount of total dissolved solids at a surface of said membrane.

25. The filtration system of claim 1 wherein at least one parameter of said optimized pulsed fluid flow is determined by a configuration of said filter element.

26. The filtration system of claim 25 wherein said parameter comprises pulse frequency and pulse amplitude.

27. The filtration system of claim 25 further comprising at least one control to vary said parameters.

28. The filtration system of claim 27 wherein said control is manual.

29. The filtration system of claim 27 wherein said control is automatic.

30. The filtration system of claim 27 further comprising at least one permeate quality monitoring device.

31. The filtration system of claim 30 wherein said at least one permeate quality monitoring device comprises a flow meter.

32. The filtration system of claim 30 wherein said at least one permeate quality monitoring device measures total dissolved solids.

33. The filtration system of claim 32 wherein said at least one permeate quality monitoring device comprises a conductivity meter.

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34. The filtration system of claim 30 further comprising a feedback loop, wherein said control is varied to optimize a quality of permeate as determined by said permeate quality monitoring device.

35. The filtration system of claim 34 further comprising an electrical measurement device, wherein said electrical measurement device measures an amperage load on said system.

36. The filtration system of claim 35 wherein said control is varied additionally to minimize said amperage load on said system.

37. A method for filtering a substance comprising the steps of:

providing at least one filtration element;

providing a pump which pumps a pulsed flow of the substance to the filtration element;

varying at least one parameter of the pulsed flow to optimize a desired characteristic of permeate filtered by the filtration element and the pump.

38. The method of claim 37 wherein the step of providing a pump comprises providing a diaphragm pump.

39. The method of claim 37 wherein the step of providing a pump comprises providing a dual head pump.

40. The method of claim 39 wherein the step of providing a dual head pump further comprises connecting the two pump heads.

41. The method of claim 40 further comprising the step of sealing a discharge port of a retentate head when a feed pressure exceeds a retentate pressure.

42. The method of claim 41 wherein the step of sealing the discharge port comprises providing a differential pressure activated valve.

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43. The method of claim 39 wherein the step of providing a dual head pump further comprises providing a pressure recovery.

44. The method of claim 43 wherein the step of providing a pressure recovery further comprises reducing energy required to filter the substance.

45. The method of claim 37 wherein the step of providing a filtration element comprises providing a reverse osmosis element.

46. The method of claim 45 wherein the step of providing a reverse osmosis element comprises providing a spiral wrapped element.

47. The method of claim 46 wherein the step of providing a spiral wrapped element comprises providing at least one membrane and at least one thin feed spacer in the element.

48. The method of claim 47 wherein the step of providing at least one membrane and at least one thin feed spacer in the element comprises reducing the amount of total dissolved solids at a surface of the membrane.

49. The method of claim 37 wherein the step of varying at least one parameter of the pulsed flow comprises varying a pulse frequency and a pulse amplitude.

50. The method of claim 37 wherein the step of varying at least one parameter of the pulsed flow further comprises measuring a desired characteristic of permeate.

51. The method of claim 50 wherein the step of measuring the desired characteristic of the permeate comprises measuring a permeate flow rate.

52. The method of claim 50 wherein the step of measuring the desired characteristic of the permeate comprises measuring total dissolved solids in the permeate.

53. The method of claim 50 wherein the step of varying at least one parameter of the pulsed flow further comprises measuring an amperage load on the pump.

54. The method of claim 53 wherein the step of measuring the amperage load on the pump further comprises minimizing the amperage load on the pump.

55. The method of claim 53 further comprising providing a feedback loop to automatically vary the parameter of the pulsed flow, thereby optimizing the desired characteristic of the permeate and pump.

56. A pressure recovery filtration system comprising:

a dual head pump comprising a primary feed head, a secondary retentate head and a connection between the two heads;

a filtration element; and

a hydraulically actuated differential pressure activated valve.

57. The pressure recovery filtration system of claim 56 wherein at least one of said heads comprises a diaphragm.

58. The pressure recovery filtration system of claim 56 wherein said connection is mechanical.

59. The pressure recovery filtration system of claim 58 wherein said connection is a shaft.

60. The pressure recovery filtration system of claim 56 wherein said connection is hydraulic.

61. The pressure recovery filtration system of claim 56 wherein a force on said secondary retentate head offsets a force on said primary feed head.

62. The pressure recovery filtration system of claim 61 wherein said valve seals a discharge port of said retentate head when a feed pressure exceeds a retentate pressure.

63. The pressure recovery filtration system of claim 62 wherein said valve comprises an inlet port connected to said retentate head and an inlet port connected to said feed head.

64. The pressure recovery filtration system of claim 63 wherein said valve actuates according to a relative pressure difference between said inlet ports.

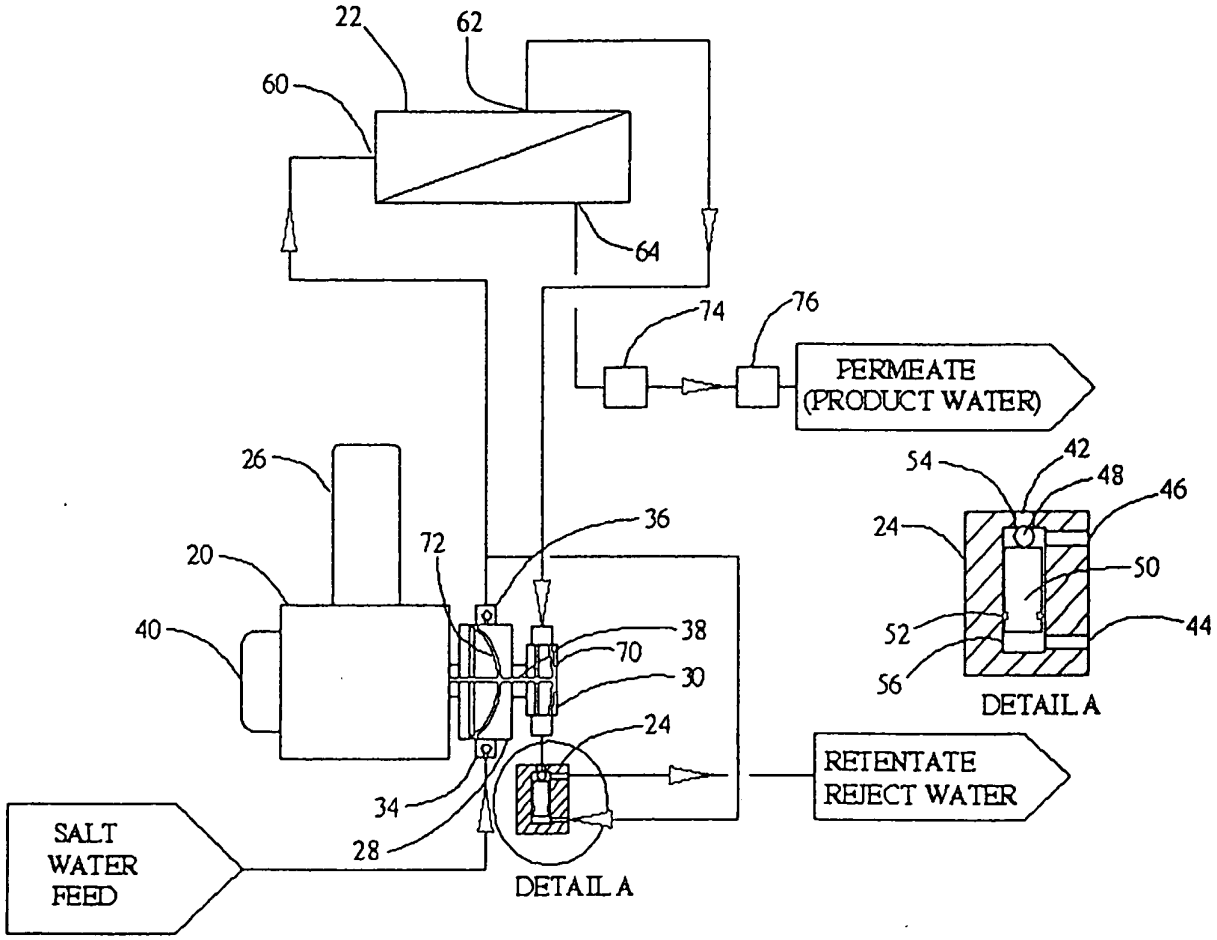

FIG. 1 DUAL DIAPHRAGM PUMP DRIVEN MEMBRANE SYSTEM